100 parts (weight)	Green chrome ...	require	15	parts of oil.
,,	,,	Chrome-yellow ...	,,	19	,,
,,	,,	Vermilion	,,	25	,,
,,	,,	Light red	,,	31	,,
,,	,,	Madder-lake	,,	62	,,
,,	,,	Yellow ochre	,,	66	,,
,,	,,	Light ochre	,,	75	,,
,,	,,	Cassel's-brown ...	,,	75	,,
,,	,,	Brown manganese	,,	87	,,
,,	,,	Terre verte	,,	100	,,
,,	,,	Parisian-blue	,,	106	,,
,,	,,	Burnt terre verte ...	,,	112	,,
,,	,,	Berlin-blue	,,	112	,,
,,	,,	Ivory-black	,,	112	,,
,,	,,	Cobalt	,,	125	,,
,,	,,	Florentine-brown ...	,,	150	,,
,,	,,	Burnt terra sienna	,,	181	,,
,,	,,	Raw terra sienna ...	,,	240	,,

According to this table a hundred parts of the quick-drying white-lead are ground with twelve parts of oil, and on the other hand, the slow-drying ivory-black requires one hundred and twelve parts of oil.

It is very important that artists should have an exact knowledge of these matters. But it seems to me that they are insufficiently known to most of them. All, of course, know perfectly how different the drying quality of different colours is. But that these different colours introduce into the picture so different a quantity of oil, and how large this quantity is in the colours they buy, and further, that the oil as well as the mediums or siccatives they add to dry the colours, are gradually transformed into a caoutchouc-like opaque substance, which envelops and darkens the pigments; and moreover, that the oil undergoes—not in the beginning, but much later on when it is already completely dry—changes of volume, and so impairs the continuity of the picture—all this is not sufficiently known. Otherwise, the custom of painting with the ordinary oil colours to be bought at any colourman's, would not have been going on for nearly a hundred years in spite of all the clearly shown evil results; results due, chiefly, TO THE PRINCIPAL ENEMY OF OIL PAINTING, THAT IS TO SAY, THE OIL.

That the masters of the fifteenth and sixteenth centuries did not use colours prepared in this way you may consider as absolutely certain; and if we hear the lost secret spoken of, and if we read that the pupils of the old masters had to pledge themselves to keep the secret, we may be sure that it is neither the method of painting nor the pigment used for it which is concerned in that secret, but exclusively the way of preparing the colours. The preparation was a very complicated one, varying with the different pigments; and we know that the pupils passed six years, that is half of the apprenticeship, in grinding the colours for the master.

And therefore it is to this very point that everyone who wishes to study the method of the old masters must first of all direct his attention. I, too, was led by the study of this question to analyse and restore old pictures. The possibility of making such analysis we owe to the relation between the old masters and their pupils. Of course we could not dissect or chemically analyse works of Titian or Raphael. But fortunately the pupils painted with the same material and by the same method as the masters, and thousands of pictures by the pupils, *well preserved* or in different stages of decay, may be easily procured.

I have myself, from among a very great number of such pictures, selected about one hundred specimens, part of which I have brought before you. As their artistic value is not, as you perceive, of the highest description, we need not feel any scruple in experimenting upon or even destroying them, if we can thereby gain any valuable information.

(*To be continued.*)

GAS-LIGHTING BY ELECTRICITY

FOR some time past the street lamps in Pall Mall, Waterloo Place, and part of Regent Street, have been connected by wires, which may have led the uninitiated to think that a new method of fixing telegraphic wires was about to be adopted. This is not the case, however, for although the wires were connected with a battery, they were not intended to convey telegraphic messages, but to experiment on a new method of lighting street lamps by means of electricity. The inventor of this method is Mr. St. George Lane Fox, who recently described his invention to the Society of Arts. Should Mr. Fox's method be adopted, the wires, instead of running from lamp to lamp above ground, will be carried along under ground, and the only thing visible would be a small piece of boxed-in mechanism just under the burner of each lamp. The experiment which was made on Saturday afternoon was not, we believe, completely successful. The magneto-electric machine and the battery which supply the current were placed in a small temporary instrument-house at the bottom of Waterloo Place. At the first trial the whole of the lamps in the circuit were lighted by the current, though in a second trial some of the lamps failed to respond to the current; but that this was owing to some local cause is probable from the fact that the first and last lamps in the circuit always responded to the discharge. We shall endeavour to explain the method adopted by Mr. Fox.

Fig. 1.

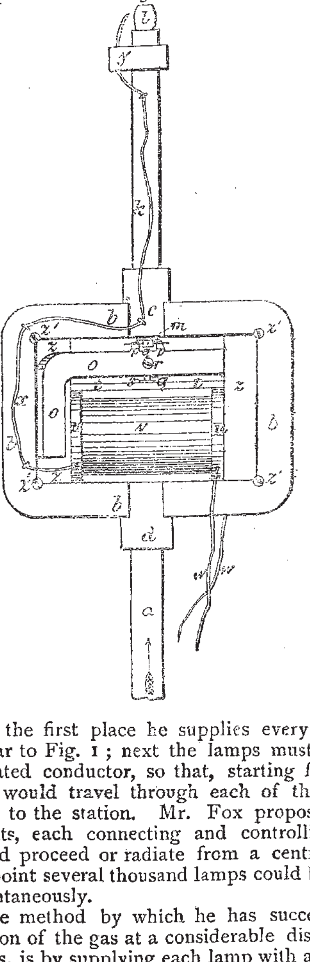
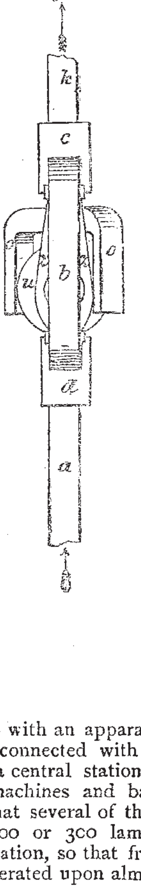


Fig. 2.



In the first place he supplies every lamp with an apparatus similar to Fig. 1; next the lamps must be connected with an insulated conductor, so that, starting from a central station, a wire would travel through each of these machines and back again to the station. Mr. Fox proposes that several of these circuits, each connecting and controlling 200 or 300 lamps, should proceed or radiate from a central station, so that from one point several thousand lamps could be operated upon almost instantaneously.

The method by which he has succeeded in producing the ignition of the gas at a considerable distance, and at numerous points, is by supplying each lamp with a small induction coil, so that the primary wires of each one of these induction coils forms part of the circuit, so in fact as to preserve without a break the metallic continuity of the line. After several experiments it occurred to him that in reality the amount of work to be done in producing a number of small electric sparks was extremely minute, although at the same time requiring to be produced almost instantaneously. Now the amount of work which an electric battery will produce is dependent on the time during which action continues, and in a single instant, or say the thousandth part of a second, the actual amount of power available is naturally extremely small, and he thought that if he could by any means accumulate this power for a short time and then bring it suddenly to bear upon the circuit, the desired result would be obtained. By means of an apparatus he succeeded in accumulating the electric current and storing it up into the condenser or

electric reservoir, which is composed of glass plates and tin-foil laid side by side alternately.

The condenser, however, is not charged direct by the battery, but the current is made to work this Ruhmkorff induction coil, from which there is derived a current having an enormously increased electromotive force, and it is this electricity that is stored up in the condenser.

Having charged the condenser in this fashion, the whole of the electricity is at once sent through the line, and produces most extraordinary results. So much, then, for the lighting of the gas. The process of turning on and off the gas, although involving many important details, is very simple. Mr. Fox makes use of the soft iron core which runs through the centre of the coil to produce a reciprocating horizontal motion of a permanent horse-shoe magnet, suspended on needle-points just above the coil. The soft iron core with the primary coil is, in

Fig. 3.

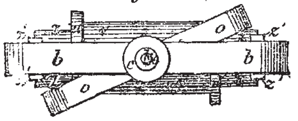


Fig. 5.

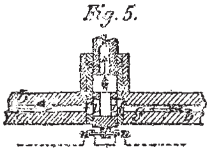


Fig. 4.

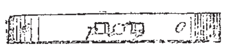
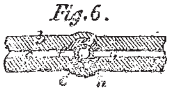


Fig. 6.



fact, an electro-magnet, which can be magnetised so as to render its poles reversible at pleasure; the magnets are carried in a small metal frame, having a passage through it for the gas to pass to the burner at the top, and being provided with a stop-cock, or valve, which is actuated by the reciprocating magnet. The whole of this apparatus is inclosed in an air-tight metallic case, which measures about $2\frac{1}{2}$ inches high, by $2\frac{1}{2}$ wide, and is screwed on to the supply-pipe in the lamp, the insulated conductor or line-wire being carried down the interior of the lamp-post and laid under ground, except, of course, where an overhead line is admissible. The turning of the gas on and off is accomplished by opening and closing what may be termed an electric needle-tap. The plug of this needle-tap is cylindrical, and about a quarter of an inch in diameter, and is carried in a socket, which it fits rather loosely. It is made to turn in this socket by the action of the reciprocating magnet, a couple of studs, which are brought into contact with a small pin or lever connected with the plug, and forming, in fact, the handle of the stop-cock. The annular space between the plug and the socket (which is about one-thousandth part of an inch) is filled with some liquid, which is retained by capillary attraction between the two surfaces, the joint being thus rendered perfectly gas-tight. The oil of bitter almonds or glycerine are both well adapted for this purpose, on account of their non-oxidisable character, and from the power they possess of resisting the action

Fig. 7.

Fig. 8.

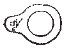


Fig. 9.

of very low temperatures. A special feature in the apparatus is the introduction of a fixed core, which can be magnetised, so as to render its poles reversible at pleasure, and in conjunction with it a movable magnet, the polarity of which is permanent. An electric current sent either forwards or backwards for a few seconds will turn the gas on or off in every lamp in the circuit according to the direction of the current.

To put the system into practical operation, there would be for any district of, say two or three thousand lamps, a central station, from which the wires would proceed in every direction, so as to command a number of distinct circuits; all that is necessary to have at the central station would be a battery of some sort. Mr. Fox would much prefer a magneto-inductor. By means of a switch and a commutator the electric current from this machine can be directed so as to operate separately on each one of the circuits, and by this means turn the gas on or off. When the gas is turned on it is lighted by sending a discharge from the condenser. It is constructed of alternate metallic plates, with an insulator or dielectric between them; the conducting surfaces in this case are of tinfoil, and the dielectric of crown glass. The coil used for charging the condenser need not give more than about three-quarters of an inch spark in the air. The discharge, like the current, will of course have to be sent through each circuit separately, and this is also done by means of the switch arrangement.

The accompanying figures will enable the reader more clearly to understand the description we have given above.

Fig. 1 is a front elevation, Fig. 2 a side elevation, and Fig. 3 a plan of the apparatus; Fig. 4 is a plan of the permanent magnet; Figs. 5 to 9 represent details to be referred to.

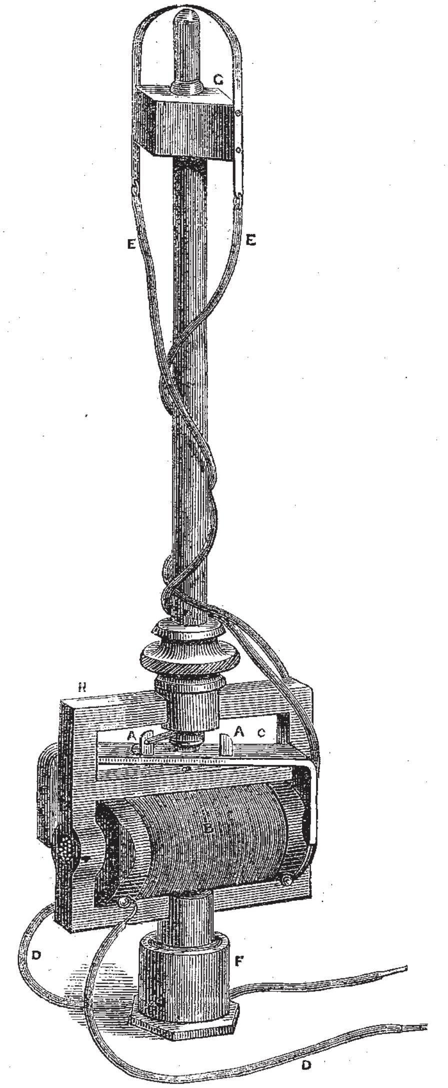


FIG. 10.

a is the gas-pipe leading from any ordinary source of supply; *b b* is a rectangular frame of white metal or brass, cast or made with a hollow core, and having two cylindrical portions, *c d*. The part *d* is screwed upon the gas-pipe *a*, which supports the apparatus, and the part *c* receives the stop-cock; this cock, which is shown in sectional elevation in Fig. 5, and in sectional plan in Fig. 6, is composed of a brass tube *e* (shown separately in Fig. 7), which fits into the cylindrical part *c*, and has two openings, *f f*, corresponding with the passages *g g*, in the opposite sides of the frame *b b*; *h* is the plug of the cock (shown separately in Fig. 8); it is made with a very slight downward taper, and has two apertures or ways *i i*, corresponding with the openings *f f* in the tube *e*, and it is hollowed out in the middle. When the gas is turned on, the apertures *i i* come opposite the

openings ff, the gas having then a free passage from the pipe a through the two sides of the frame bb, and into and through the plug h. It will be seen on reference to Fig. 6, that a small turn of the plug is sufficient to open or close the cock. k is a pipe screwed into the tube e, and leading to the burner l. m is a projection at the lower end of the plug, and n is a pin passed through the same. The plug is supported on the point of the pivot on which a magnet turns, so that very little power is required to turn the plug. o is a permanent magnet, which may be either cast in steel, with the two projecting pieces pp, or made out of a steel bar bent into the proper shape, and in this case the projections pp are produced by screwing in two pieces of metal. q is the pivot on which this magnet turns; it is passed through a vertical hole in the magnet, and fixed by a screw r. The lower end of the pivot rests in a steel step s, which is supported by a small wooden beam t, secured to the ends of the wooden bobbin u. v is the induction-coil; it is composed of a core of soft iron wires, two layers of primary wires wound with covered copper wire of about No. 20 BWG, and upon these about ten to fifteen layers of secondary wire of about No. 40 BWG. The primary wires ww form part of the circuit by which the lamps to be lighted or extinguished simultaneously are connected. One end of the secondary coil is connected to an insulated wire x, leading to the burner l, where it terminates in a platinum point, and the other end is connected to the frame b, or to any other metallic part of the apparatus, so as to be in metallic connection with the burner. The insulated wire x passes through an earthenware support y (seen in plan in Fig. 9), fixed to the pipe k. The soft iron core projects about three-eighths of an inch from each end of the wooden bobbin u. The bobbin is fastened to wooden supports zz, which are fixed to the frame b by screws $z^1 z^1$.

Fig. 10 (for the use of which we are indebted to the Society of Arts) is a view of the complete apparatus as attached to a gas lamp.

AMERICAN SCIENCE

THE March number of the *American Journal of Science* opens with a valuable paper, in which Prof. Norton collates the various observations made on Coggia's comet. The theory of cometary phenomena he arrives at is (briefly) that the direct action of the sun on the side of the nucleus exposed to the solar rays is to form an envelope of gaseous carbonic oxide. This envelope of diamagnetic gas is traversed by the ideal lines of magnetic force proceeding from the nucleus, which are also lines of conduction through the gas. The electricity set free by the ascending currents of gas, by reason of the diminished gaseous pressure, is propagated along these lines, and the impulsive force of the electric currents detaches streams of the successive molecules of the gas in the direction of the lines of conduction. Both the nucleus and the sun exert repulsive forces on the escaping molecules; but their effective actions may be either repulsive or attractive, according as their attraction prevails over the attraction of gravitation, or the reverse. The author elucidates this theory at some length.

In a reply to Mr. Mallet's review (in the *Philosophical Magazine*) of General Abbott's paper on the velocity of transmission of earth-waves, in which the value and accuracy of the Hallet's Point observations were doubted, the General describes some new observations on the subject, which seem to establish these points: 1. A high magnifying power of telescope is essential in seismometric observations. 2. The more violent the initial shock the higher is the velocity of transmission. 3. This velocity diminishes as the general wave advances. 4. The movements of the earth's crust are complex, consisting of many short waves first increasing and then decreasing in amplitude, and, with a detonating explosive, the interval between the first wave and the maximum wave, at any station, is shorter than with a slow-burning explosive.

A new method for decomposition of chromic iron, proposed by Mr. Smith, consists in exposing it (in an exceedingly fine state) with bromine to a temperature of 180° C. from two to three days. Prof. Marsh furnishes an account of some new Dinosaurian reptiles.—Prof. Kimball describes some experiments on journal friction at low speeds.—There are also notes on some reactions of silver chloride and bromide, brightness of the satellites of Uranus, &c.

The new number of *Appalachia*, the journal of the Appalachian Mountain Club, contains a valuable address by the president, Dr. S. H. Scudder, in which he reviews the principal scientific expeditions in the United States during the past year. Dr. Scudder himself is attached to the Hayden Survey, and made the discovery of the beds of fossil insects at Florissant, near Manitou, Colorado. During the past year 20,000 fossil insects have been exhumed from this quarry.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The fifth and final report of the Syndicate appointed in May, 1875, to consider the requirements of the University in different departments of study, has been issued. The Syndicate have considered the question of the residence to be required of professors. They are of opinion that it is desirable—(1) that the time for which the University may require the residence of professors shall be left to be determined by the University in the case of each professorship, without any general statutable restriction; (2) that no professor shall be considered to satisfy the condition of residence who is not for the time required making his home within a mile and a half of Great St. Mary's Church, unless special permission, available for not more than one year at a time, but renewable, be granted by the Vice-Chancellor and Sex Viri, and that such permission shal not be granted unless the Vice-Chancellor and Sex Viri are satisfied that the professor has made such arrangements as will secure his being reasonably accessible in Cambridge during term time. The Syndicate have also had under their consideration the importance of individual personal intercourse between students and teachers, and it has also been suggested that the inspection and revision of students' note-books by the teacher may in many cases be of considerable use. The precise manner in which such personal intercourse may be most effectually secured will probably vary very much in different subjects and for different teachers, but it seems important that the arrangements should be such that the professor himself may in all cases see a portion of the work of his class, so as to make himself accurately acquainted with their wants. The Syndicate have referred to the Board of Medical Studies the question whether it is desirable to found a complete medical school in Cambridge so as to make it possible for a student to complete his whole medical course here, or whether it is better for all concerned, while making the teaching at Cambridge as perfect as possible in the scientific subjects which are the basis of medicine, to leave students to carry on elsewhere the greater part of their clinical studies and most of what relates directly to the practice of medicine. The reply of the Board of Medical Studies states that they consider it inexpedient that students should complete their whole professional education at any single medical school, and that it is therefore desirable that students should pursue their studies away from Cambridge for a year or more before commencing practice, either before or after their final M.B. examination. They believe, however, that it would be in most cases advantageous to students to carry their medical studies in Cambridge further than is usually done at present, and in some cases as far as the final M.B. examination, and they are therefore of opinion that the University should provide systematic instruction in all the subjects necessary for a medical degree, as is done at other Universities. In order that this may be carried out satisfactorily the Board of Medical Studies think that the University should provide:—1. A Professor of Pathology. 2. A Professor of Surgery. 3. Systematic teaching in (1) midwifery and the diseases peculiar to women (2) medical jurisprudence; (3) sanitary science; (4) mental diseases. 4. Systematic clinical teaching.

R.G.S. PUBLIC SCHOOLS' PRIZE MEDALS.—The following is the award of the Public Schools' Prize Medals annually given by the Royal Geographical Society:—Physical Geography—Gold Medallist, William John Newton, of Liverpool College; Silver Medallist, Christopher Mounsey Wilson, of Clifton College; Honourably Mentioned—E. G. Harmer, University College School; M. H. Clifford and M. A. Soppitt, of Dulwich College; and J. S. G. Pemberton, of Eton College. Political Geography—Gold Medallist, William Wallis Ord, of Dulwich College; Silver Medallist, George Arnold Tomkinson, of Haileybury College; Honourably Mentioned—A. R. Ropes, of the City of London School; A. Kay, of Rossall School; and D. Bowie, of Dulwich College.